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EDITORIAL NOTES

A RETICENT BODY

IT seems to us that we are for the time being in something of a whirlpool of thought with "planning" as the vortex. This applies generally and the Gas Industry is obviously concerned. Perhaps we have been guilty of over-optimistic thoughts regarding planning in the Gas Industry. Some time ago a Gas Industry Planning Committee was formed, but it seems to have taken cover under a dense smoke-cloud of obscurity. To the Gas Press—at any rate as far as we ourselves are concerned—the Committee has said nothing whatever apart from, perhaps, "Wait, we will tell you when anything happens." We have heard nothing first-hand—that is, officially—about the Committee's work, and therefore, *officially*, we can only assume, and pass on the information, that the Committee is doing little or nothing.

The Committee's veil of secrecy can, of course, be pierced. It certainly should be pierced. We are becoming tired of the mysterious shrouds with which Gas Industry committees cloak themselves, and in many instances we cannot accept the facile excuse that "understandable wartime circumstances" (or some other phrase of like description) preclude publication of this or that committee's august findings. What is there so very mysterious, for example, about the Gas Industry's Post-War Planning Committee? We are not alone in asking this question—not by a very long chalk indeed. Rumours reach us from many channels to the effect that the Committee is active; information reaches us ("dishonestly" if you will) which we assess as having worth beyond mere rumour. We hear nothing at all from this B.G.F. Committee itself, which—once again as far as we are concerned—has shunned the open light of publicity. Why should this witch-doctor performance either continue or be allowed to continue while the rank and file of the Industry become either increasingly restive or quite blankly indifferent?

After all, there is plenty to be done about this planning and any amount of considerations which can profitably be discussed openly without retarding the war effort, and there are many in the Gas Industry who are weary of this doctrine of silence. To our mind just criticism may be looked upon as a globule of mercury which will slip away dispersed under the thumb of clumsy authority only, however, to reform. The "GAS JOURNAL" poses neither as philosopher nor index of political thought or trends, but it would like to understand why the obviously important work of the Post-War Planning Committee cannot be ventilated. A Committee, we take it, looks upon itself as a team and acts accordingly; it ceases to be a teamwork body just as soon as it ceases to take into its confidence those for whom it is presumably acting and without whose backing and support it would have no *raison d'être*. We would add that in the ultimate mass opinion will have an influence.

It is trite to say that there are problems about us now, and perhaps equally trite to say that, post-war, problems will abound. One of the major questions will be that of employment, coupled with the economic use of buildings, plant, and technique. There will be changes in practice, but the social services, among which gas ranks high, will have to continue to give of their best irrespective of change. And whatever the changes, we believe that the Gas Industry can continue advantageously with a solid background; but it ought to consider what this background is, and then develop from it. Maybe force of circumstances has been partially responsible for the goodwill the Industry has built up. In certain directions it may have been "shackled" by legislative chains, though we have found comparatively few people outside the Industry who could find the shackles, and comparatively few people in the Industry who could explain clearly how and to what extent the shackles actually operated. For example, without dividend restrictions and, incidentally, safeguards, would co-partnership have flourished so easily and so smoothly in the Industry? Without certain privileges and restrictions would the Industry have developed that sense of obligation to the public which has coloured and influenced the activities of the Industry to increasing degree in recent years?

Without certain restrictions, will the Industry face post-war problems well? Is the Industry going to be strong within itself or confused by internal competition? We have spoken of employment, and we think that the "coal to consumer" industry, of which the Gas Industry is part, will be able to offer a steadying influence and an example. The field for thought here is vast. At the moment we will think about but one small patch, and that concerned with one side only of the Industry's activities. We think that after the war there will be a very big demand for new gas appliances. Will the gas appliance firms of proved repute in peacetime, anxious to satisfy the new demand, fight each other for business, or will they act co-operatively on some plan evolved during the war period? Can there be a system of agreed quotas based on capacity of production and technical ability to fulfil the Industry's requirements, which cannot remain static and will to our mind be more exacting? Where does that capacity lie, or where will it lie? Ought a survey of capacity and likely capacity to be instituted now, based on round-table, team-work discussion? Is co-partnership between workers and employers making gas appliances impossible—a co-partnership which will ensure that the workers can be reasonably happy in a sense of security of tenure? Or are we going to leave such matters to chance, meantime marching circle-wise under the banner of fortuity? Are such questions of interest to the Gas Industry's reticent Post-War Planning Committee?

LIGHTING

THERE has been a certain amount of discussion lately on the subject of artificial lighting in the reconstruction period after the war, but as far as we are aware the part which gas may then occupy in this important field has not been very much considered—at all events, openly. We do not know what planning moves, if any, are being made in this direction or with what, if any, enthusiasm the problem is being regarded. What, we would ask, is going to be the Industry's attitude towards domestic, public, and industrial lighting, and what are its thoughts and inclinations on the matter now? Does the Industry intend to retire gracefully from the arena of lighting in the home, and what are its plans about street and factory illumination? Is it developing any new or improved forms of equipment for future application in any of these spheres?

Official statistics showed that before the war authorized gas

undertakings were selling approximately 15,000 million cu.ft. of gas for public lighting purposes to local authorities, representing a by no means inconsiderable proportion of the total gas sold. Before September of 1939 each month saw the making of new long-term contracts by gas undertakings for public lighting and all-round improvements of existing installations. It was being realized in increasing measure that street lighting demands scientific technique, and small undertakings which had at their disposal expert advice and assistance, through co-ordinated control, from a central office were showing excellent and encouraging results. Is this good work to be fruitfully continued after the war? What about gas *vis-à-vis* electricity in the field? Before the war there was undignified scrambling for public lighting in which, as pointed out clearly by Mr. Chandler in his William Young Memorial Lecture last autumn, both sides set about slashing their charges, while the lighting authority aided and abetted presumably to obtain a benefit for the local rates. The winner obtained the business and wrote off the loss on it to advertising or "overheads"—an item to keep up the cost of gas or electricity service to the public which was supposed to have benefited through low public lighting rates. Are we, after the war, going to see a reversion to this type of undesirable competition from which the public interests suffer?

To ask yet another question, to what extent is the Gas Industry following the trends of industrial lighting and to what degree is it framing policy? It is not enough—or should not be enough—to be told that a Committee is maintaining close touch with this or that department. If the personnel of the Industry is satisfied with bald, non-committal statements of this nature we can only say that—even in wartime circumstances—it is very easily pleased. On this question of industrial lighting in reconstruction we have been interested in a recent Paper by Mr. C. H. Weston given to the Illuminating Engineering Society. Many changes are taking place now which are not merely war expedients, so that the end of the war will find us at a more or less advanced stage of reconstruction rather than at its beginning. This applies to industrial lighting. New war factories have been equipped with installations planned to provide artificial lighting to recognized standards of good practice; some have set new standards. The importance of improved lighting in factories was stressed once again by the Select Committee on National Expenditure six months ago, which stated that "the cost in labour and materials of making the necessary improvements may be far outweighed by the resulting increases in output." As Mr. Weston remarked, compared with the last War industry is now much more dependent on artificial lighting, and as a result workers are likely to become more light-conscious. The large number who will see the war through in the vital factories will experience conditions of lighting which, for many of them, represent a new high standard. Those who subsequently return to other factories will look for conditions at least equally good. There will, we think, be a growth of interest in good factory lighting among those concerned with management. What place will gas lighting fill in the new order after the war?

Water Heating Research

We publish to-day the main findings set out in a new bulletin on domestic gas water heating research issued by the American Gas Association. The bulletin is the second on the subject and it is confined to a single phase of water heater performance—the principles of gas storage water heater design for maximum hot water delivery. It covers the effects of heat application in gas water heaters on stratification or separation of hot and cold water during heating periods, as well as the effectiveness of dip tube design and other methods of introducing cold water to storage vessels in accomplishing and maintaining separation of hot and cold water during draw periods. It provides additional technical information on a subject where "rule of thumb" methods in America have largely prevailed, and it seems to us to reflect the advantages to be gained from co-operative research enjoying full support from the manufacturers of appliances. The importance of the subject is indicated by the fact that prior to the entry of America into the war more than 800,000 gas water heaters were placed in service in American homes each year; of these, considerably more than half were of the automatic storage type embodying a storage tank. The bulletin states that manufacturers of gas water heaters have been active and successful in improving the thermal efficiency of their heaters, and reducing heat losses from storage vessels to the extent that within practical limits no great reduction in operating costs may be expected from future developments in that direction. It is added, however, that little information on dip tube design and stratification characteristics has been published. Yet, if insufficient attention is given to dip tube design it it easily possible that a 40-gallon heater would deliver no more usable hot water than a 20-gallon heater having an effective dip tube. Assuming equal performance of the two in other respects, the smaller heater would have an operating cost over 20% lower than the larger unit, to say nothing of the saving in initial cost. Proper introduction of inlet water to a water heater storage vessel may accomplish the same purpose as increasing the size of the storage tank or, conversely, it may permit the use of a smaller water heater for any given service.

Personal

The B.B.C. announced on Monday that to facilitate the reorganization of the Corporation, which the Board of Governors has undertaken to meet existing conditions, the Director-General, Mr. F. W. Ogilvie, has placed his resignation in the hands of the Governors, and they have accepted it. The duties hitherto discharged by the Director-General will be entrusted for the duration of the war to two Directors-General jointly, and the Governors have appointed Sir Cecil Graves, hitherto Deputy Director-General, and Mr. Robert Foot, at present their General Adviser on Wartime Organization, to these positions. Mr. Foot, who was brought in as an expert administrator from the Gas Light and Coke Company, of which he had been General Manager since 1929, will look after the huge work of management.

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Mr. ARCHIBALD D. COUBROUGH, Engineer and Manager of the Biggar Gas Company, Ltd., has been appointed Manager of Duns Gas Light Company.

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Mr. J. A. HUNTON, General Works Manager, and Major W. R. BROWN, D.S.O., Sales Manager, of Ashmore, Benson, Pease & Co., Ltd., have been appointed Directors of the Company.

Obituary

Many friends in the Gas Industry will be sorry to hear that the wife of Mr. W. M. Galleway, Deputy Chairman of the Whitby Gas Company, died after a short illness on Jan. 18.

Letters to the Editor

Calorific Value of Gas

DEAR SIR,—I was very interested in the Address by Mr. James Jamieson ("JOURNAL" of Dec. 17, 1941) on the subject of calorific value. During the rapid development of vertical retorting plant which followed the termination of the War of 1914–18, the range of gas qualities then being supplied was reviewed throughout a period of changing conditions. In the latitude bestowed on the Industry by the Order of 1916, I recollect occasions in my own personal experience when calorific value was as low as 375 B.Th.U.; and on the passing of the Gas Regulation Act in 1920 I recommended the adoption of a "declared value" of 420 B.Th.U. in Johnstone, the standard still in existence in that town. Of the four large cities, Edinburgh, Glasgow, and Aberdeen declared 500 B.Th.U., and Dundee 450 B.Th.U.

I came to realize that so low a quality as 400 B.Th.U. could not be manufactured in downwardly heated continuous-intermittent retorts, heavily steamed in order to obtain a high amount of liquid products—for both tar and sulphate of ammonia recovery were then made worth while—without bringing "saleable" coke down to the level of 5 cwt. per ton with a quality of gas containing 15% of inerts. Disproportionately high fuel consumption in the producers set in when steaming was in the region of 20% and over. There was the problem to contend with then as now, so admirably put by Professor Cobb in a William Young Memorial Lecture relating to the recovery of ammonia, of conveying through the walls of the retort "not the comparatively small quantity of heat required for carbonizing, but the comparatively enormous amount necessary to gasify completely the carbon by the water gas reaction."

To-day, in being asked to make a personal choice, the two-stage process of gas production would influence a decision between 450, 425 and 400 B.Th.U. quality. With 450 quality, present-day conditions in the oil market demand drastic reductions in the amount of oil used, compared with consumption in 1938–39. In considering, however, the one-stage process of manufacturing coal gas and blue water gas in downwardly heated continuous vertical retorts and a benzole extraction of 2 gallons per ton of coal, from what experience

I have gathered in the carbonization of nearly all qualities of Scottish gas-making coals, the average production, under existing restrictions of choice, would as likely as not average 65 therms per ton or a gas yield of 450 quality approximating 14,500 cu.ft. In my opinion, attempts to go far beyond that figure will result in reduced benzole recovery and extravagant coke consumption in producers. It requires to be kept in mind that a goodly proportion of gas in Scotland is manufactured in this design of setting.

The coke market to-day can absorb all the coke that a 450 B.Th.U. gas quality will provide, but the trend of gas manufacturing costs is upward, abruptly so during the second year of war.

Although Mr. Jamieson has proved to his own satisfaction that 450 B.Th.U. quality is as high as any quality in Scotland need be, and that the cheapest therm can be made with that quality, he states, "So far as Edinburgh is concerned I shall be surprised if 450 B.Th.U. or indeed 425 B.Th.U. will not be permanently established." I am definitely of the opinion that so far as the matter concerns Scotland 450 B.Th.U. should be the maximum quality, but if *one* standard quality for Scotland is to be achieved, quite obviously it must be by means of a compromise of views while taking into full account the design of operating plant and the markets for secondary products. With a combination of vertical retorts and C.W.G. plant or horizontal retorts and gasification plant, the step down to 425 quality would be comparatively simple, though not so simple for upwardly heated, and indeed difficult for downwardly heated, continuous vertical retorts while endeavouring to maintain the maximum output of benzole with which to assist the national war effort. To-day my personal choice would be 450 B.Th.U. quality rather than 425, and should the coal situation become such that a recasting of view becomes essential, then 425 rather than 400 B.Th.U. A reduction from, say, 4.5 to 4 therms per 1,000 cu.ft. of volume delivered to the consumer would require substantiation by way of a reduction in manufacturing and distributing costs. If such were not forthcoming the result might be, in the average of cases, equivalent to an increase of 1½d. per therm in the price of gas. And it is most difficult to discern whence such reduction can come.

Dundee Gas-Works. Yours faithfully,
Jan. 17, 1942. J. DICKSON.

Gas in Post-War Homes

DEAR SIR,—While endorsing fully the advantages to hygiene of a chimney per room, as advocated in your editorial on p. 92 of the "JOURNAL" of Jan. 21, may I put in a plea for a fully adequate chimney? One of the seldom heard merits of a chimney as a means of ventilation is that it operates with 100% efficiency during the blackout (so many wall ventilators are closed to prevent the escape of light). Secondly, the chimney is the quietest means of ventilation known (how often is the wall ventilator shut to keep out the medley of sounds). Thirdly, a chimney must be as large as practicable for maximum ventilation in the sultry summer nights, but should be fitted with a damper to control somewhat ventilation to the winter's cold, or even to close the chimney altogether should the room be out of use for a long period in winter's frosts.

43, Uxbridge Road, Yours faithfully,
Hampton, Middx. H. J. TOOGOOD.
Jan. 24, 1942.

Coloured Tar Surface Dressings

Coloured surface dressings for roads, &c., form the subject of a patent (No. 541,575; application date, July 3, 1940) taken out by the Midland Tar Distillers, Ltd., and D. W. Parkes.

The patentees point out that many attempts have been made to produce coloured surface-dressings for roads, for the purposes of distinguishing traffic lanes, pedestrian crossings and so forth, and camouflaging large areas of concrete and macadam. In one method, aggregate is mixed with a binder of light colour and sufficient pigment is incorporated to bring the whole to the desired colour; the coloured macadam thus produced is then laid to a thickness up to one inch and consolidated. This method, they state, is expensive, since sufficient pigment must be used to colour the whole of the material, although only the surface is visible, and furthermore the binders are liable to discolour through slow chemical change and thus to dull the brilliance of the original material. In another method chips are covered with pigment, and then a bitumen binder is added until both the pigment particles and the chips are covered with a thin film of the binder. By this method it is impossible to produce a matt surface, such as is given by exposed pigment particles.

Natural stones of different shades have also been used for surface dressing; the contrast, however, is not great, well-defined colours are not available, and two suitable colours are rarely available in the same locality, so that transport charges are heavy. Attempts have also been made to dye road chips prior to application, but it is difficult to dye road chips, and most chips that can be dyed are porous. As a result, when they are wet most of the light falling on them is absorbed and the effect of the applied colour becomes negligible, the colour of the chips reverting to that of the wet natural stone, which is usually dark and often almost black.

According to the present invention, chips or any other materials suitable for surface dressing are thinly coated with a waterproof binder, which may advantageously be refined tar, and pigment particles are applied to the coated material in such a way that they are held by but project from and are not submerged in or coated by the binder. Enough pigment is used to hide the binder substantially completely, so that the colour of the binder is immaterial. Even so, as the pigment is not incorporated into the binder but is merely applied to its surface, the amount used is not great and the process is not expensive. The resultant material is waterproof and hardly changes colour when wet.

In carrying out the process the coating is preferably made thinner than the average particle diameter of the pigment. For instance, brown brick dust having an average particle diameter of 0.01 in. may be applied to chips coated with binder to a thickness of about 0.005 in.—that is to say, with coatings so thin that they are mere films on the material. Other colours may be produced by using ground scrap from coloured ceramic products, such as coloured tiles. When the invention is carried out in this way the amount of pigment used will as a rule be in the order of 10% or more of the chips by weight, although this figure depends, of course, upon the specific gravity of the pigment.

The patentees go on to say that most true pigments are of extremely small particle size, being made either artificially or from natural minerals which can be regarded as aggregates of very fine particles, and which are so soft that they break down into those fine particles very easily. Such pigments must be used if it is desired to have a wide field of colours from which to choose, but it is not always feasible to make a simple coating of binder so thin that these pigments would not be submerged. According to a further feature of the invention, the coatings, in order that they may be made as thin as possible, say between 0.001 and 0.005 in., are first nearly saturated or impregnated with powder, and then the finely-divided pigments are applied. Application of the powder, which may be, for example, granite flour, limestone dust, whiting, or slate dust, has the effect of reducing the film thickness of the binder so that it becomes of the same order of magnitude as that of the pigment particles, and this very thin coating is found to be sticky enough to hold a thin layer of the pigment. If the process is stopped at the point when the coatings are nearly saturated or impregnated, the material has a glossy appearance, showing that the powder has been submerged in the binder. On adding the pigment in slight excess of the amount which can be taken up a matt finish is obtained, showing that the pigment particles have not been completely submerged. Most pigments are so expensive that it simply is not feasible to mix with the binder enough of them to perform both the saturating and colouring functions. Such a powder as granite flour is, however, cheap and therefore its use in place of a substantial amount of pigment leads to a considerable economy. Thus when the invention is carried out in this way the pigment particles may be used in an amount as low as 4% of the chips by weight.

By proceeding as set forth, coloured chips are produced with excellent wearing properties and with colour stability equal to that of the pigment employed. Moreover, the colour is not affected at all by that of the binder.

An example of a method in which a pigment of greater particle diameter than the thickness of the coating is used is as follows: 500 lb. of ¼ in. granite chips were heated to 75–80°C. 14 lb. of refined tar of relatively high viscosity (having an equiviscous temperature of 57.5°C.) and containing no light oils were added and the whole was mixed until the chips were completely coated. 64 lb. by weight of red brick dust passing through a sieve having 60 meshes to the linear inch but stopped on a sieve having 90 meshes to the linear inch were then mixed in at a temperature of about 65°C. When cool, the brick dust adhered firmly to the chips, which were of a red brown colour.

A further example is as follows: 525 lb. of clean ¼ in. granite chips were heated to 70–85°C. and coated with 13 lb. of quick-drying refined tar having a B.R.T.A. viscosity of 90 seconds at 30°C. 14 lb. of air-separated granite dust were then added and when thoroughly incorporated, 30 lb. of green pigment were added. The mixing was carried out in an ordinary tar macadam mixer, the mixing being completed in about 3 minutes.

In general a low viscosity tar requires a low mixing temperature. However, the chips to be coated are often wet and a high temperature is required to dry them. Therefore, with wet chips, a high viscosity tar must be used or else the tar must contain a proportion of volatile oil which will be driven off during the mixing of the tar and chips, and thus increase the viscosity of the tar. The latter procedure is preferable in cold weather because of the difficulty in handling high viscosity tars. The coarser the powder the higher should the viscosity of the binder be.

The fact that goods made of raw materials in short supply owing to war conditions are advertised in the "Journal" should not be taken as an indication that they are necessarily available for export.

BACTERIAL REMOVAL OF HYDROGEN SULPHIDE FROM WATER GAS AND COAL GAS BY PEAT AND PEAT-OXIDE MIXTURES*

By R. QUARENDON

NOW that supplies of Dutch bog ore can no longer be obtained, a cheap readily available material of domestic origin to supplement burnt spent oxide and other oxides produced in this country becomes of special interest. Research carried out at Billingham during the last three years shows that peat can be used effectively as a purification material in oxide boxes. Its use as a lightening agent for improving the mechanical properties of iron oxide is, of course, well known; under suitable conditions, however, it functions also as an active purification material on its own account by virtue of its sulphur bacteria which oxidize hydrogen sulphide to sulphur. These conditions, which were discovered largely by chance during attempts to extend the life of iron oxide, are easily realized and controlled and involve no radical change in the working of the oxide boxes. The sulphur bacteria are very tolerant of conditions met with under industrial operation and appear capable of withstanding all the extremes likely to be encountered. They oxidize the hydrogen sulphide almost quantitatively to sulphur.

Discovery of Application of Sulphur Bacteria

During 1938 the Billingham Research Laboratories of I.C.I. (Fertilizer and Synthetic Products), Ltd., were investigating methods of improving the performance of bog ore in the oxide boxes used for purifying water gas and producer gas. The performance was unsatisfactory inasmuch as bog ore could not in general be fouled above 45–50% sulphur (dry basis) without serious loss of activity.

Laboratory experiments were therefore undertaken on lightening agents for increasing the life of the oxide, including peat of the type used in horticultural work. Comparative fouling tests made on mixtures of these lightening agents with spent oxide showed that the peat-oxide mixture absorbed twice as much sulphur as that absorbed by spent oxide alone or by its mixtures with wood shavings or slag. It was evident that the good results obtained with the peat were due to something more than a mere mechanical effect.

Peat is known to contain sulphur bacteria which oxidize the hydrogen sulphide produced by the breakdown of the proteins in the decaying organic matter. We therefore filled one of our experimental towers with peat alone and found that its removal activity was as high as that of new bog ore. In these laboratory tests we obtained complete initial removal of hydrogen sulphide, and were able to produce from peat alone a spent mass containing 70% of sulphur (dry basis).

The gas which was being purified in these experiments normally contains no ammonia, but we found on emptying the experimental towers that the mass smelled strongly of this gas. This ammonia was derived from an ammoniacal liquor with which the line serving the laboratories had become contaminated during previous use with coke oven gas. Since we have established that ammonia is necessary for successful operation, its presence in the gas being purified was a fortunate chance which led to the discovery of the activity of peat for bacterial purification.

Characteristics of Sulphur Bacteria

Sulphur bacteria are widely distributed micro-organisms occurring in nature only in association with the sulphur or sulphur compounds which are essential for their metabolism. They are subdivided into sulphur-reducing and sulphur-oxidizing types; it is, of course, the latter which are concerned in sulphur removal by bacteria in peat.

All the sulphur-oxidizing bacteria are extremely simple in their requirements. They are autotrophic—that is, they use carbon dioxide as their source of carbon and do not require any organic matter: they obtain their nitrogen from ammonium salts. Most of them are aerobic, requiring at least a small concentration of oxygen for their development, and the majority flourish best in a medium of pH between 6.5 and 8.0. Sulphur bacteria are not very sensitive to temperature within limits, for like all soil organisms, they are subjected naturally to extremes of temperature; between 20° and 30°C. is probably the most favourable figure. The conditions in the oxide boxes probably form as suitable an environment as could be found under somewhat artificial conditions. There they are supported on their natural medium with its large surface area; carbon dioxide and oxygen are supplied; ammonium salts are present in the peat, and ammonia is also added, probably serving as a source of nitrogen as well as raising the pH; and finally, a continuous supply of hydrogen sulphide is available for them.

As far as we have been able to discover, the sulphur bacteria of peat have not yet been studied in any detail by previous workers.

Gas purified at Billingham.—The water gas purified at Billingham has the following composition, after the amount of air or oxygen needed for revivification has been added prior to removing hydrogen sulphide: N_2 2.0, H_2 54.0, CO 36.5, CO_2 6.5, H_2S 0.2–0.3, O_2 0.3, CH_4 0.3%. The chief points of interest in connexion with bacterial purification are the amount of hydrogen sulphide, which is much less than that present in coal gas, and the carbon dioxide content, which is some three times that of coal gas.

During the 2½ years we have been developing the use of peat for hydrogen sulphide removal on a large scale, mixtures of peat and new or partly spent oxide have been substituted for ordinary oxides in almost all the oxide boxes. Thus, although more work remains to be done on the precise conditions governing bacterial activity, the process has passed well beyond the stage of mere experiment and is now an established part of our gas purification practice.

Method of Using Peat

The practical application of the bacterial process of purification in oxide boxes by means of peat involves no radical alteration of the normal method of operation. It consists merely of mixing a suitable proportion of peat with the oxide (as is done with a lightening agent such as wood shavings) and the addition of a comparatively small amount of ammonia to the gas being purified to bring the sulphur bacteria into an active condition. The ordinary mixing facilities available at gas-works are suitable. The conditions for successful operation are by no means critical.

There are two grades of peat available for use, described by the trade as "granulated peat" and "peat tailings." These names refer to the two finer sizes obtained when the air-dried blocks of peat from the moor are broken up at the mills. At Billingham, practically all our experience has been concerned with the use of peat tailings, which are considerably coarser than the fines.

Our disintegrator is of the rotating cage type commonly used at gas-works. It handles the peat with great ease, producing a finally disintegrated peat of about the same size as the original tailings, plus some fines produced during disintegration.

After the peat has been mixed with the oxide by means of a grab crane, the heap is sprayed thoroughly with water through a hose to raise the water content to 50–60%.

The presence of sufficient ammonia in the gas being purified is a very important factor in successful purification by means of peat. The water gas purified at Billingham contains no ammonia. It must therefore be added to the gas entering the oxide boxes. There are fortunately ample supplies of readily available ammonia.

0.04% of ammonia (12.5 grains per 100 cu.ft.) is normally used for the gas containing 0.3% of hydrogen sulphide; the corresponding rate of ammonia addition is thus some 6 cu. m. per hour. Thus the amount of ammonia required is about three times that normally allowed to enter the first box in town gas purification.

At Billingham it is the practice to add the above amount of ammonia to the inlet of the third as well as to the first box. Of the total ammonia added to the set, about three-quarters is absorbed. At a gas-works the necessary amount of ammonia at the first box can easily be arranged by adjusting the water used on the ammonia scrubbers. A different means must obviously be used if additional ammonia is required at the third box. Where ammonia stills are in use, there should be no difficulty in supplying this secondary ammonia; where they are not, the problem becomes more difficult.

It sometimes happens that a fresh unused mass may not attain its maximum activity until two or three days after the box has been put on line, thus differing from oxide, which gives maximum removal at the start. This behaviour is specially noticeable when a high proportion of peat is used—that is, when the oxide in the mixture is doing only a small proportion of the hydrogen sulphide removal. With one mixture containing 66% of peat by volume it was necessary to use 0.07% of ammonia for a day or two until maximum removal efficiency had been attained. The reason is probably (*a*) that the peat does not at first contain sufficient bacteria in an active condition to deal with all the hydrogen sulphide to be removed, so that they must be given time to multiply until there is a sufficient bacterial population to deal with all the hydrogen sulphide which the physical conditions allow them to receive, and (*b*) that ammonia is used to neutralize the acidity of the peat.

As in purification by means of iron oxide, oxygen must be supplied to enable the sulphur bacteria to function, and is of course necessary for revivification of the oxide in peat-oxide mixtures. Twice the stoicheiometric amount of oxygen required to oxidize the hydrogen

* Abstract of a Paper read at a joint meeting of the Newcastle Section of the Society of Chemical Industry and the Coke Oven Managers' Association on Nov. 27, 1941. Editorial reference to the Paper was made in the "JOURNAL" of Dec. 10, 1941.

sulphide according to the reaction $2H_2S+O_2=2H_2O+2S$ gives good results on the plant scale. It is added not as air but as oxygen.

Quite a wide latitude is permissible in the temperature of peat-oxide mixture. Temperatures between 25° and 30°C. are normally used in our plant boxes, but as high as 35° and as low as 20° have been quite satisfactory in semi-technical tests. Much lower temperatures can be used with peat unmixed with oxide without adverse effect on hydrogen sulphide removal activity.

Normally a relative humidity of about 80% is maintained during winter and 100% during summer. Under these conditions excessive loss of water from the mass does not occur.

Performance of Peat and Peat-Oxide Mixtures Purifying Water Gas—Large Scale Operation

Excellent results have been obtained with mixtures of peat tailings with new and spent Dutch bog ore, with new and spent proprietary oxide, and with new English bog ore, in each case using equal volumes of peat and oxide. Each of these mixtures can be recommended for satisfactory service under Billingham conditions. Most of our experience has been concerned with a mixture of peat and spent oxide.

Excellent results have also been obtained by adding an equal volume of fresh peat to an already spent mixture of equal volumes of peat and spent oxide. Such a mixture is equivalent to using in two stages three volumes of peat to one of original spent oxide. It is now proposed to try the effect of adding another equal volume of peat to the spent mass thus obtained. It will be specially interesting to see how far this dilution of spent mass with fresh peat can be carried.

Peat used without oxide was only moderately successful. Although in the one large-scale test carried out a reasonably high quantity of sulphur was absorbed before the peat was exhausted, it could be kept on the line long enough to enable it to absorb this amount of sulphur only because it was backed by peat-oxide mixtures in the sequence; the removal efficiency of the 100% peat box was very erratic, being very good on one day and poor a few days later. It would not be safe to use peat alone in all four boxes under these conditions.

We are inclined to attribute this apparently capricious behaviour primarily to changes in the physical condition of the peat, as influenced by changes in water content. Although peat can hold a high percentage of water, the weight of water per unit volume is not very high. The peat can therefore dry out fairly easily and in doing so may lose its activity. At the same time, any parts of the mass which owing to differences in temperature conditions may be wetter than the rest will offer more resistance, so that most of the gas may tend to pass temporarily through the less reactive, dry portion of the mass.

Another mass which has considerable interest is a mixture of two volumes of peat and one volume of burnt spent oxide, now being tried on the large scale after excellent results had been obtained in semi-technical tests on a mixture of equal volumes of peat with the same oxide. The proportion of peat was doubled for the large-scale test because it was feared that the fineness of the oxide might cause pressure drop to develop. Preliminary results show that the mass is very active.

Assuming that the spent mass so obtained is suitable for use in spent oxide burners, it is proposed to remix the burnt oxide obtained therefrom with fresh peat for further fouling. By recycling the burnt oxide several times in this way, it is hoped to limit the consumption of new material exclusively to peat, which, of course, will be burned away with the sulphur each time the mass passes through the spent oxide burners.

The substitution of peat-oxide mixtures for oxide has been a fairly gradual one, but we are now beginning to obtain the full results from the change, and can form a reliable estimate of the benefits it has brought. These are: Greater gas purification capacity, larger average sulphur removal capacity per fouling, and lower purification costs.

Peat-oxide mixtures retain their activity for a longer period than oxide masses. The average weight of sulphur absorbed from the gas by peat-oxide mixtures before becoming spent is some 10% greater than the weight absorbed by oxide without peat.

When research on the use of peat was begun we were considering extension of the oxide boxes because at times they limited factory output. The increase in sulphur removal capacity, therefore, brought a corresponding increase in gas purification capacity. Whereas before the use of bacterial purification only a small proportion of the spent oxide could be sold, there is now no difficulty in raising the sulphur content to 55–60% (dry basis). By extending the policy of mixing fresh peat with spent peat-oxide, it should be possible to achieve 60–65% (dry basis) because peat has such a low bulk density compared with oxide.

It is not necessary to purify the gas at Billingham as rigorously as statutory regulations demand for town gas purification. A gas containing 1 part of hydrogen sulphide per 100,000 by volume is satisfactory, whereas the requirements for town gas correspond with about 1.5 parts per million. It must not be thought, however, that bacterial purification is not capable of achieving the latter degree of purification. We achieve a purity of 1 part per million or less in favourable circumstances when masses are fresh, but not all the time. Our boxes are relatively only about half as large as those in use at gas-works and so cannot be expected to give as high a degree of purification. It must be remembered that town gas contains two to three times the amount of hydrogen sulphide present in Billingham gases. We think it should be quite feasible to obtain the necessary degree of purification in gas-works, as is shown by large-scale tests (see later).

Fresh mass removes 95–98% of the hydrogen sulphide when in the first position, and most of the hydrogen sulphide in subsequent positions. During fouling the removal efficiency gradually falls to 50% in the first position, when a box must be emptied. The mass is then replaced for a second fouling; it has then not quite such a high initial activity and absorbs less sulphur before being again removed. A third fouling may be given if it appears to be justified. In general, the activity of peat-oxide mixtures does not fall off so much during the fouling as it does with oxide alone. After the third fouling a spent mass is usually discarded for pressure drop instead of low hydrogen sulphide removal efficiency.

Generation of hydrogen sulphide sometimes occurs when using peat, when a box is in the third or fourth position. The degree of purification is thus at times not so good as it otherwise would be. Generation takes place towards the end of a fouling.

Burning of Spent Peat and Peat Oxide

The spent masses containing peat have been chiefly utilized for sulphuric acid manufacture in one of I.C.I. factories employing both a continuous Herreshoff mechanical burner and a hand-fed burner consisting of a battery of long narrow horizontal chambers. Tests have also been made in Wyld, Harris, Moritz, and de Spirlet burners.

The bulkiness of spent peat and of spent peat-oxide containing a high proportion of peat tends to reduce the rate of feed in the mechanical feed designed for use with spent oxide. A slight modification of the feeding apparatus easily overcomes this difficulty.

It might be thought that the products of combustion of the peat would cause undue dilution of the burner gases, but in practice there is little difference. The spent mass contains 2.5–4% of carbon. Peat-oxide should be no worse in this respect than oxides containing a large proportion of wood as lightening agent. The ammonia causes no trouble; in fact spent peat-oxide is just as satisfactory as ordinary spent oxide from gas-works or from our own boxes. We have admittedly no experience of the burning of spent peat-oxide from gas-works. Spent Billingham mass contains very little tar.

Purification of Coke-Oven Gas and Coal Gas

We have also carried out comparative semi-technical life tests on peat, peat-oxide mixtures, and oxide alone in the purification of coke-oven gas. These tests indicate that these mixtures should give at least as good performance in large-scale practice as oxide. It was felt, however, that large-scale tests would be more convincing than small-scale tests, and through the kind offices of the High Temperature Carbonization Committee of the Ministry of Mines, we also arranged for peat and peat-oxide mixtures to be tested in oxide boxes at a works of the Gas Light & Coke Company under the supervision of Dr. Hollings.

Large-Scale Tests on Coal Gas

A large-scale test has been carried out under the supervision of Dr. Hollings at one of the works of the Gas Light & Coke Company on peat fines alone; another test on a mixture of equal volumes of partly-spent oxide (H_2O 20%; S 38%) and peat fines is now in progress. The boxes used have a cast iron construction, and contain one 3-ft. bed of mass 48 ft. by 32 ft. The gas being purified contains 0.65–1.2% H_2S (413–748 grains per 100 cu.ft.). At times operation has been irregular owing to war conditions, but this does not appear to have adversely affected the performance of the mass. During the test on the peat alone the ammonia concentration in the gas entering the box was allowed to rise to 0.2–0.4% (average 83 grains per 100 cu.ft.), but during the test on the peat-oxide mixture an average of only 0.08% has been used (25 grains per 100 cu.ft.). No addition of ammonia is made after the first box of a set.

The test on peat alone was unsuccessful. Although good at first, the activity of the mass soon fell away very much. The efficiency of the box when in the first position fell to 50% after only 17 days in the first position during 27 days' operation in rotation. The box continued to operate for some time afterwards but the normal volume of gas could not be passed through it owing to war conditions. The reason for the loss of activity is obscure because the fouled peat was very active when subsequently tested in the laboratory. The mass was originally charged to the box in the "as received" condition containing 38% of water—a rather low figure for peat fines.

As in the case of the semi-technical laboratory tests at Billingham, the mass contained a considerable amount of ammonium thiocyanate. This was particularly high in that portion of the layer of peat which first received the gas. Here again we think, in view of our later experience, that the concentration of ammonia used was unnecessarily high.

An average sample of fouled peat from the box contained H_2O 32%, free S 20%, and NH_4CNS 15%. Much of the fouled material contained only about 10% H_2O and 5% of free sulphur.

The test on the peat-oxide mixture is giving much better results. To the end of September this box had been on the line for 112 working days, and is giving 80–99% removal of the inlet hydrogen sulphide in all positions. The hydrogen sulphide in the gas leaving the box

when in the last position was originally 0.005 part per million and has now risen to 0.05 part per million. It is too early to say how the life of the mass will compare with ordinary oxide, for as yet it has absorbed only about half the amount of sulphur taken up by oxide alone during one fouling. It may be that under present conditions we are not making full use of the bacteria in the peat. Should the activity of the mass diminish it could possibly be improved by increasing the ammonia concentration. The pressure drop continues low. All that can be said at present is that this mass has made a promising start.

Semi-Technical Tests on Mixtures of Peat

As peat alone has not given very satisfactory results, the question of supplies of suitable oxide for mixing with it becomes of importance. The most obvious oxide for this purpose is burnt spent oxide, which could under favourable conditions be used over and over again. In addition there are considerable quantities of waste red mud from the aluminium industry as well as smaller quantities of black oxide from aniline manufacture. Another possible oxide is burnt pyrites, while proprietary oxides must be considered. We are carrying out a programme of semi-technical life tests on mixtures of peat with these oxides which are giving some very promising results.

The results so far obtained suggest that any form of iron oxide can be mixed with peat with satisfactory results. Even comparatively inactive oxides, such as burnt spent oxide, waste red mud, and burnt pyrites, appear to be suitable. The beneficial action of oxide may be merely a mechanical effect, or it may be that in some way the iron oxide favours the bacterial action. We have been especially impressed by the ability of peat-oxide mixtures to function at low moisture contents.

In the laboratory a systematic investigation is in progress of the various factors which may be expected to influence the activity of the bacteria in the peat. This investigation has been pursued chiefly from the more practical aspect of the effect on removal efficiency of peat masses, but bacteriological work on more classical lines on the isolation and identification of the bacteria in pure cultures is also in progress.

It was found that the activity of the peat was sensitive to changes in water content. The activity rose continuously as the water content was increased to about 40%. Thereafter no increase was observed. There was some evidence, however, that if the peat were thoroughly wetted at the beginning and then dried in stages, it retained its activity at moisture contents down to 25%. The explanation may be the difficulty of wetting the peat by the addition of a limited amount of water to an already dry material. Once the peat has been thoroughy wetted, the removal of some of the water may still leave sufficient to maintain activity. Further experiments are in progress to test this effect of loss of water during fouling. Wetting agents reduced the amount of water which must be added to the dried peat to give maximum hydrogen sulphide removal.

Some preliminary tests on the substitution of ammonium sulphate, diammonium hydrogen phosphate, ammonium nitrate, and urea for gaseous ammonia, without any addition of alkali to raise the pH, have been made. In each of these cases the hydrogen sulphide removal was negligible. It will be seen therefore that so far no effective alternative to the use of ammonia has been found. At Billingham ammonia is a very convenient method of securing bacterial activity, but it is possible that for coal gas and coke oven gas purification other means may be more suitable.

Tests were made with coke oven gas on peat alone and on equal volumes of peat and bog ore. It was found that the removal efficiency increased as the ammonia concentration was increased in stages of 0.010–0.015% from an initial 0.015%, and reached a maximum at 0.05–0.06% NH_3. Even 0.015% of ammonia produced some removal of hydrogen sulphide, however. It is possible that a comparatively low ammonia concentration would suffice to maintain maximum hydrogen sulphide removal once the mass has been brought into an active condition at a higher ammonia concentration. This point is being examined. The above results refer to a gas containing 0.4% of hydrogen sulphide.

England, Scotland, and Ireland all have large quantities of peat, much of which should be suitable for gas purification. The probable difficulty in meeting any large-scale demand would be not the extent of peat resources, but the lack of facilities for exploiting the existing deposits, coupled in wartime with a large demand for other purposes. We estimate that the increased annual demand for peat if all gas undertakings used a 1/1 peat-oxide mixture (by volume) would be some 130,000 tons of air-dried material containing 30% of water.

Summary

Peat can be used effectively for the removal of hydrogen sulphide from water gas, coal gas, and coke oven gas in oxide boxes by virtue of the sulphur bacteria it contains. It is best applied by mixing it with iron oxides, when it functions both as a lightening agent and as a purification mass.

Mixtures of peat with an equal volume of new or spent bog ore, or with burnt spent oxide, have excellent sulphur removal capacity, and when fresh give trace removal. Good results are obtained by mixing more peat with the spent peat-oxide mixture.

0.04–0.06% of ammonia is generally necessary in water gas to bring the bacteria into an active condition; 0.04% suffices to maintain maximum hydrogen sulphide removal. The hydrogen sulphide is oxidized almost quantitatively to sulphur. Peat-oxide mixture has a greater activity than bog ore alone and retains its activity for a longer time.

Peat-oxide mixtures containing a high proportion of peat burn well in spent-oxide burners and give a satisfactory concentration of sulphur dioxide.

The hydrogen sulphide removal efficiency of peat varies ltitle between 5° and 30°C., but rises rapidly as the O_2/H_2S ratio rises to about 0.8 and thereafter more slowly. Peat loses its activity when it becomes dry, but peat-oxide mixtures can be used effectively at low water contents.

Peats of various types and ages differ little in bacterial activity, but young fibrous high-moor peats having an open structure are best suited for use in oxide boxes.

GAS STORAGE WATER HEATER DESIGN

WE have received from the American Gas Association Bulletin No. 12 on the "Principles of Gas Storage Water Heater Design for Maximum Hot Water Delivery." It is the second bulletin on the subject and is confined to a single phase of water heater performance. The research work comprising the bulletin may be divided into two parts—namely, (1) a study of the influence of heat application to water heater storage vessels in producing stratification or separation of hot and cold water during heating periods; and (2) a study of effectiveness of dip tube design or other methods of introducing cold water to the storage vessel for accomplishing a separation of hot and cold water during draw periods. Both are concerned with the delivery of usable quantities of hot water, the first by quick recovery of a small amount, and the second by delivery of a large quantity commensurate with the size of the storage vessel involved. It is made clear that nothing presented should be interpreted as indicating that any specific type of design or construction is advocated or recommended over another. "An earnest effort has been made merely to present the facts; readers are expected to draw their own conclusions." The following shows the main results in summarized form.

First regarding the accumulation of hot water during the heating process. Studies of water temperatures existing at different levels in storage vessels of selected and representative contemporary types of gas water heaters during the heating process indicate:

(*a*) When heat is applied directly to a storage tank, water temperatures throughout its entire contents are essentially uniform during the entire heating period.

(*b*) When heat is applied indirectly through a separate unit (side-arm or "spreader" types) and the hot water conveyed through a pipe and discharged near the top of the storage vessel, stratification or a differential between top and bottom temperatures will take place during the heating cycle. A 40°F. temperature differential is common for these types of heater. On models investigated, temperature differentials ranged from a minimum of 20°F. to a maximum of 89°F. Any desired degree of stratification may be obtained by appropriate heater design.

(*c*) On side-arm type heaters, greater temperature differentials may be effected by locating the circulating water connexions at the extreme top and bottom of the storage tank. As the vertical distance between these two connexions decreases the temperatures throughout the storage tank become more uniform and approach the performance of an underfired type heater.

(*d*) On "spreader" type heaters the temperature differential between top and bottom of the storage tank depends on the relative amount of heat which is utilized by the "spreader" arrangement and that which is transferred to the water through the bottom or flueway in the storage vessel. Temperature differential will also increase as the internal pipe length is increased, as this design discharges the heated water nearer the top of the tank.

(*e*) Accumulation of hot water at the top of a storage vessel increases the rate of recovery for a portion of the stored water without an increase in input rating. On one side-arm heater studied, the rate of temperature rise at the top of the storage tank was 1.65°F. per min. for the entire heating period, while the average rate of rise for the entire volume was 0.8°F. per min.

(*f*) For any given maximum water temperature and size of storage vessel a water heater that produces uniform stored water temperatures will make available at end of heating period a larger quantity of hot water than one in which stratification takes place.

Test on a 30-gall. (actual capacity 28 gall.) range boiler with circulating tank heater attached to extreme side outlets indicated a heat content above 70°F. of 18,600 B.Th.U. with a top temperature of 168°F. When the top connexion to the heater was 2 ft. lower, and with the same top temperature of 168°F., the heat content was 20,300 B.Th.U. This increase resulted from the fact that the average tem-

perature in the latter case was greater (157°F.) than in the former (150°F.), due to less temperature difference between top and bottom tank levels. If the temperature had been uniform throughout, the heat content above 70°F. would have deen 22,900 B.Th.U.

(*g*) The practical capacity of heaters producing stratification of stored water is limited by the fact that corrosion of the galvanized storage vessel is greatly accelerated at higher water temperature. Therefore, top temperatures higher than those normally used (140°–160°F.) would not be advisable in producing a quantity of hot water comparable to that delivered by heaters carrying uniform water temperatures throughout.

Continuous and Intermittent Draw Periods

Secondly, regarding the delivery of hot water during continuous and intermittent draw periods. Influence of location and direction of flow of cold water introduced into a water heater storage vessel on the heater's ability to deliver usable hot water (water at a temperature of 120°F. or higher) was determined by (*a*) visual observations of water movement in storage vessels, and (*b*) other experimental determinations of quantities delivered employing different locations and types of dip tubes or other means for introducing inlet water.

Visual observations were made of the nature of water discharge from various types of dip tubes both in the open air and in specially constructed storage tanks with observation windows. Circulation of water was made visible by introducing a coloured water-soluble dye in the inlet water stream. Characteristics of various types of dip tubes were observed as follows:

(1) On open-end dip tubes a distinct separation of hot stored water and cold inlet water occurred when the inlet stream had just sufficient momentum to move slowly across the tank bottom and exhaust itself at the tank wall. This occurred in most instances when the dip tube outlet was 4 in. above the tank bottom.

(2) Characteristic discharge from an open-end tube is not altered by providing slots extending upward from the tube bottom, or by extending the tube with wire screen, unless it is placed so close to the tank bottom that water is forced through such side openings in a manner similar to that of horizontal discharge type dip tubes.

(3) Closed-end dip tubes with horizontal openings discharge inlet water at an angle of approximately 10–20° below horizontal.

(4) Drilled side openings of closed-end dip tubes are effective in releasing water into a storage vessel up to a point where the combined area of these openings is equal to that of the inside cross-sectional area of the dip tube. Upper openings in excess of that area release practically no water.

(5) Dip tubes having a circular disc supported in a horizontal position below the open end of the tube discharge water at an angle of 45° below the horizontal. With a ¾-in. O.D. dip tube and a circular disc of the same diameter this angle of discharge does not change when the disc is kept within the limits of ¼ and ¾ in. distance below the end of the tube.

(6) Dip tubes designed to discharge water at a 45° angle below the horizontal created the least turbulence when placed in the centre of the storage vessel with the inlet stream directed at the crevice formed by the junction of the storage vessel bottom and the shell. Results with this type of dip tube were much less satisfactory when located 4 in. off centre, in line with contemporary storage water heater construction.

Experimental determinations of the effectiveness of various types of dip tube designs and their proper location for optimum delivery of usable hot water were made on a wide range of types and sizes (15 to 80-gall.) of storage gas water heaters. These included both continuous and intermittent draw tests with various types of dip tubes and under many different conditions to determine the effect of all essential factors having a bearing on the delivery of hot water. Results may be summarized as follows:

(1) Delivery volume of usable hot water decreased as the distance between dip tube discharge openings and storage vessel bottom increased. A 20-gall. 12-in. I.D. storage tank delivered 94.6% of usable stored heat with an open-end dip tube located 2 in. above its bottom, while only 78.5% was delivered with a similar dip tube located 27 in. above the bottom. A 40-gall. 18-in. I.D. heater delivered 90% of its stored heat in usable form with dip tube 4 in. above tank bottom, but this was reduced to 70% when 26 in. above tank bottom.

(2) In general, location of the dip tube discharge openings within 8 in. of the storage vessel bottoms permits a greater delivery of usable hot water than at higher positions. However, within this range there is a wide difference in results obtained, especially with smaller storage vessels. On a 40-gall. heater with open-end dip tube, results varied from 84 to 90% of usable stored heat, while on a 20-gall. heater the results ranged from 72 to 94.5%.

(3) Open-end dip tubes gave best average results over a range of draw rates from 2 to 6 GPM when placed 4 in. off centre with their outlets 4 in. above the storage vessel bottom (measured from centre of tank bottom). This was verified in storage tanks from 15 to 80 gall. in capacity.

(4) Closed-end dip tubes with horizontal openings gave best average results in quantity of usable hot water delivered when the centre of the horizontal openings was from 3 to 3½ in. above the centre of the storage vessel bottom (openings in 3 horizontal rows ½ in. apart).

Performance of closed-end dip tubes with horizontal openings and open-end dip tubes with vertical discharge openings was, within practical limits, equal when each was located in its optimum position.

(5) The quantity of usable hot water increases with an increase in area of horizontal openings up to a point equalling the internal area of cross-section of the dip tube. Increase of area above that point had no significant effect on the percentage of usable stored heat delivered.

On a 20-gall. heater with dip tubes in optimum location above the tank bottom 83.4% of usable stored heat was delivered when the area of the horizontal dip tube openings was 44% of the internal area of the dip tube (¾ in. diameter). Delivery of usable hot water increased to 93.5% at 110% of the dip tube area, and remained constant within practical limits for larger areas of horizontal openings, being 94.2% when the area of the horizontal openings was 176% of the dip tube area.

(6) Dip tubes having a circular disc supported in a horizontal position below the open end of the tube permitted delivery of a greater percentage of usable hot water when located in the centre of the tank at such a height that the discharge stream was directed at the crevice formed by the junction of tank bottom and side wall. When located off tank centre, this type of discharge outlet was much less effective. In a 20-gall. heater the percentage of usable hot water delivered was 96.4% with the dip tube in the centre, while it was reduced to 73.3% when located off centre, both being at optimum distances above tank bottom.

(7) Storage vessels of large capacity are less critical to small variations in placement of dip tubes. On an 80-gall. capacity water heater, variations from 2 to 4 in. above tank bottom for an open-end tube caused no practical change in usable stored heat delivered.

(8) Introduction of inlet water to the storage vessel in such a manner that its velocity will be quickly dissipated results in delivery of a greater percentage of usable hot water. Increase in open-end dip tube diameter from 0.185 to 0.824 in. I.D. increased delivery of usable stored heat from 67 to 90.5%, other conditions being equal.

(9) Introduction of cold water through the drain valve usually gave better results than obtained with dip tubes in their optimum position. This was due, in part at least, to the larger diameter of such openings, in comparison with that of a ¾-in. O.D. copper dip tube.

(10) Within practical limits, vent openings at top of dip tubes have no effect on percentage of usable stored heat delivered on either continuous or intermittent draws. This is of particular significance, since a vent opening is necessary to prevent siphoning of water from a storage tank under certain conditions when the inlet water supply is cut off.

(11) Functioning of a thermostat in a storage vessel depends on the temperature existing at that particular tank level and not on the proximity of the discharge opening of the dip tube.

(12) Effect of rate of draw on delivery of usable hot water depends on other factors, such as location of dip tube, and type and size of discharge openings. As the rate of draw varies greatly in service, the different locations of dip tubes mentioned in items 3, 4, and 6 above gave best average results over a normal range of draw rates (2 to 6 gall. per min.).

(13) Intermittent draws result in a slightly greater delivery of usable hot water than do continuous draws. This is due to the greater time involved, which permits a greater pick-up of heat from storage vessel and insulation.

(14) Water pressure has no effect on the percentage of usable stored heat delivered.

Immersion Tube Gas Water Heating

An aerated jet has been produced by Messrs. Thomas Potterton (Heating Engineers), Ltd., which besides having many normal gas fired uses has proved to be of particular use for firing into tubes immersed in tanks of liquid, and is being extensively used in this way for clothes decontamination and special processes in metallurgy.

A further use for these tubes has been found for heating treated water stored in narrow tanks ready for filling motor radiators with soft water, in coach and bus garages in South-East England.

To economize in fuel, central heating in the garages is not provided, therefore in cold weather the radiators of buses have to be emptied at night to prevent freezing. Now that firing tubes are fitted to the tanks, during the winter months the radiators are being filled with hot water every morning to give greater ease in starting with the heavy fuel oil employed. The water in the tank is raised to 210°F., which gives the tank a high heat capacity, and for use is cooled to an appropriate temperature to avoid any damage to cylinders.

The use of firing tubes ensured low installation cost and the least amount of steel consistent with a high overall efficiency, as effective insulation of the sides and top of the tank becomes a simple matter.

A plea for co-operation to

TRANSPORT USERS

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IN a thousand ways the blackout tends to slow down essential movement—the movement of men and munitions, of food and fuel, of all the vital supplies needed by a nation at war. The transport system needs thousands more wagons and lorries to cope with the demands upon it. Those extra vehicles cannot be *built*, but their equivalent *can* be supplied if every user of goods transport will help to increase running time, to speed up loading and unloading, and to decrease standstill time.

Let a mere 15% be saved in this way throughout the country and the result will be the same as if 100,000 extra wagons and lorries were made available.

Are you doing *your* share in getting a Quicker Turnround?

Ask yourselves these questions

1—Have you planned to make labour available to load or discharge immediately? Have you arranged to load to capacity?

2—Have you installed labour-saving equipment to speed up loading and unloading? If this is not possible, have you improvised?

3—Do you help consignees by informing them, as far as you can, when the goods you forward may be expected to arrive?

4—Are your arrangements between your office and your loading staff as good as they should be? For instance, have you arranged for the immediate checking of loads?

5—Have you talked the matter over with the men who actually load and unload?

6—Do you make the most of every hour of daylight to clear loads, carrying on into the blackout when possible?

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SPEED UP LOADING AND UNLOADING

Issued by the Ministry of War Transport

MAINTENANCE IN A 300 MILLION WORKS*

By ALEX. McNEIL

CONSIDERABLE thought and attention were given to the erection of a modern, well equipped workshop as part of the general construction of the Hamilton Gas-Works, and we are fortunate in now possessing a really efficient and admirable unit, enabling us to carry out general works maintenance in a reliable and expeditious manner.

The workshops were erected in 1939, built with red-faced bricks, comprising a single story building 50 ft. long by 24 ft. wide and 19 ft. high. Roof lights of reinforced glass of an area of 200 sq. ft. and window lights of an area of 200 sq. ft. ensure adequate daylight inside the shop. An 8 in. by 4 in. M.S.H. beam is anchored at the back wall and projects 3 ft. through the front wall, this projection being used for lifting heavy loads from lorries. In the workshops, a movable carriage supporting a ton set of chain blocks travels along this beam, and is useful for lifting work for repairs, also for lifting heavy work when boring at the drilling machine. Built to each gable end, and with access to the main shop, are the blacksmiths' and engineers' stores, each having a floor space of 200 sq. ft. These stores house light essential components for the work plant, tools, &c., with steel, round, flat, squares, and angle, bolts, nuts, &c., in the smiths' store. Heavy components, such as large valves, castings, steel joists, M.S. plates, M.I. tubing, are housed in a separate store. This was the original purifier house, reconstructed and adapted for the purpose. Floor space is 1,990 sq. ft., and sufficient room is available to lay out all the material in relation to the part of the works plant for which it is required. The material is laid out in rows with a passage between each row, so that any component can be readily seen and removed when required.

The equipment in the workshops includes:

Blacksmiths' Forge, which was built to our own design. The hearth is 4 ft. square by 2 ft. 6 in high and is built of firebrick. Overhanging the hearth is a M.S. tapered canopy with a flue leading to a chimney at the gable end. Blast is by a Keith-Blackman electric blower, giving a pressure of 12 in. water gauge and operated by a button switch. The blast is controlled by a damper slide. Three cwt. of coke beans are used in the forge weekly. The forge is situated at one end of the shop and at the other end is an open fire. This fire serves the purpose of heating the shop, and supplying hot water; it has a grate area sufficient to enable dirty greasy castings, &c., to be burnt off before carrying out any repairs on them.

Superior Grinding Buff.—This machine sits on a cast-iron pedestal 13 in. by 7 in., tapering to 15 in. by 9 in. at the base. Attached to the top of the pedestal, and central with it, is a 4.5 h.p. B.T.H. electric motor, the rotor shaft having a 14 in. carborundum grinding wheel at each end. The wheels are at 2 ft. 6 in. centres and have a speed af 1450 r.p.m. On top of the motor casing is the button switch.

4 *in. Capacity Screwing Machine.*—The screwing machine proper is surrounded by a C.I. trough filled with water and cutting oil; a small pump circulates this mixture to the cutting edge of the dies. The chuck is designed so that when the dies are set they can be released from the pipe and reset with a lever. An automatic feed pipe cutting attachment can be fixed to the face plate of the revolving die holder, cutting pipes from 2 in. to 4 in. dia. The overall dimensions of this machine are: Height 3 ft., length 4 ft., breadth 2 ft. 6in. The machine is driven by a Scott electric motor operated by a button switch. This machine is very accurate, giving an excellent finish to the threads.

4 *E Drilling Machine.*—This machine is driven by a vertical electric motor driving direct into an enclosed gear-box, giving eight drilling speeds, 80 to 705 r.p.m. The drilling spindle is graduated in eighths of an inch for the use of a depth drilling stop. This adjustable stop travels down with the drilling spindle, and when at the required depth compresses a lever, which disengages the automatic feed. The drilling table is 2 ft. in dia. and can be either lowered or raised to the required height. The overall height of this machine is 7 ft. A $\frac{3}{8}$ in. capacity chuck is used for drills $\frac{1}{8}$ in. to $\frac{1}{16}$ in. Other drills range from $\frac{13}{32}$ to $1\frac{1}{4}$ in., rising by $\frac{1}{32}$ in., and are morse taper shanked. As a cooling medium for boring we use a mixture of water and cutting oil.

Oxy-Acetylene Welding and Oxy-Coal-Gas Cutting Equipment.—This comprises a shank, cutting head with nozzles to suit coal gas and acetylene and five welding heads which can weld M. steel up to $\frac{1}{8}$ in. thick. The cutting and welding heads are interchangeable with the shank. A barrow was built with old $\frac{1}{2}$ in. gas M.I. tubing to accommodate oxygen and acetylene bottles, tubes, and welding and cutting heads, thus enabling easy transport of the plant to any part of the works. A firebrick-surfaced welding table was built, having four angle iron legs braced by flat M.S. bars. Underneath the table are racks to hold the welding rods. The welding rods we use are as follows: $\frac{3}{16}$ in., $\frac{1}{8}$ in., $\frac{1}{16}$ in. Alda low carbon copper-coated steel rods; $\frac{1}{8}$ in., $\frac{3}{16}$ in. square silicon cast-iron rods; $\frac{3}{16}$ in., $\frac{1}{8}$ in. brazing rods.

Surface Table.—This comprises a C.I. machine-finished plate supported by four angle-iron legs 2 ft. 6 in. long with levelling screws welded to the bottom and flat bar welded to angle-iron legs as bracing. This surface table comes in very useful for facing-up valves, fitting brasses, marking off flanges, &c.

The welding and cutting plant is very useful. Many repairs can be carried out by welding broken and building-up worn parts of the works plant. A few examples of the work done will serve to demonstrate this: Building-up wear and filling-up holes in extractor end plates on retort mouthpieces. Constructing a new W.D. auxiliary coal hopper, using the C.I. stool piece from old auxiliary hopper. Cutting M.S. flanges and welding them to M.I. pipe for special branch pieces. Welding broken parts of cookers, &c., for the Distribution Department. Carrying out repairs to railway, cutting rails, welding broken chairs. Patches are welded to slightly holed conveyor buckets, but when they are scrapped the side castings are removed from the old buckets, annealed, and riveted to new conveyor buckets.

You will have noticed that no mention has been made of a lathe and portable drilling machine. Unfortunately, owing to the outbreak of war, it was impossible to obtain these machines, but it is intended to install them when possible, and so complete the equipment of the workshop.

In Hamilton we have made it a practice to overhaul certain parts of the works plant at regular intervals. The exhausters are overhauled every six months and oilfeeds checked twice a week. The benzole plant high-speed Sisson engine is overhauled and the oil sump of the engine drained every 3 months. The conveyor electric motors are greased every 12 months and brush gear is checked every two months. The conveyors are attended to every week. Gas engines for the coke extractors are decarbonized and overhauled every two months. Weir pumps for the steam boilers are overhauled every six months and pumps are changed over every week.

One of the capstans was transported to the workshops for a general overhaul. New pinions were fitted where necessary, the vertical electric motor was stripped and overhauled. When assembled, the capstan was given a coat of red lead paint. M.S. flat wearing bars are fitted to the capstan bollards, held in position with $\frac{3}{8}$ in. cask setscrews. Previous to this, the bollards were electrically welded where grooves had occurred with the constant abrasion with the wire ropes. Since fitting these M.S. wearing bars maintenance costs for the capstan have been cut down greatly.

M.S. wearing bars are fitted to the inside of the retort mouthpieces, with a clearance from the curved doors. In so doing, the original castings have a much longer life.

All coke and ash barrows are constructed and repaired, also coke and ash chutes. All coke, coal, and ash chutes are fitted with M.S. wearing plate.

Much of the benefit derived from having well equipped shops can be lost through neglect to small points, such as cutting down waste material, and cleanliness; for example, one economy practised at our works is that all suitable pipe cuttings are made into connectors. By so doing we seldom have to install union couplings. Practices such as these are innumerable when one is equipped with suitable workshops, and it is only by applying these practices that the full benefits of an efficient engineers' shop can be obtained.

* Paper to the Scottish Junior Gas Association (Eastern District).

Toronto's Gas Sales for domestic purposes were well maintained during the year ended Sept. 30, 1941, while the demand for gas for industrial use was greater than in any previous year in the history of the Consumers' Gas Company of Toronto. The revenue from the sale of gas appliances showed an increase of 20% over that of the previous twelve months. For reasons with which shareholders were made acquainted at the time, the Directors in March last decided to discontinue for the present the payment of the maximum dividend of 10%; and for the March quarter, as well as for subsequent quarters in the year, they declared a dividend at the rate of 8% per annum. Recent growth in the number of gas house-heating units installed is a favourable point, because experience has proved that when such equipment has been installed in a home there has followed a greater use of gas for other domestic purposes.

"New Appliances for Old" is an excellent peace-time slogan, but under existing conditions it is difficult to put into practice. During the last financial period there has been a substantial increase in the number of modern gas appliances sold by the Consumers' Gas Company of Toronto, and it is realized to be very important to the Company's business that old and obsolete gas appliances should be replaced by new and efficient ones. "But," said the President (Mr. A. L. Bishop), addressing the shareholders at the annual meeting, "to enforce the country's prior claim to the available metals of construction, the Government has deemed it expedient to discourage the manufacture of domestic gas appliances by placing an excise tax of 25% on gas stoves, heaters, water heaters, and refrigerators. To conserve foreign exchange, the Government has prohibited the importation of all gas apparatus designed for cooking or for heating buildings, as well as refrigerators and air-conditioning units. In a further effort to reduce the purchase of household equipment, the Government has instituted regulations designed to discourage instalment buying. It is our intention to co-operate with the Government."

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Gas Products Prices

The London Market Jan. 26.

There is very little movement in the prices of Coal Tar Products, as many of the usual markets are no longer available and pitch/creosote mixture as a fuel oil has taken their place.

Pitch is still a nominal market, but for such quantities as are being sold the price ranges between about 45s. and 50s. per ton. Creosote is about 5d. to 6d. per gallon. With regard to refined tar the price for next season has not yet been definitely fixed and it is expected that this will come under a Direction to be issued by the Coal Tar Controller. Pure toluole remains 2s. 5d. per gallon under the Ministry of Supply Toluene No. 2 Order. Pure benzole is about 1s. 10d., 95/160 solvent naphtha is 2s. 5d. to 2s. 9d. and 90/160 pyridine remains about 13s. 6d. per gallon. All the above prices are *ex* Makers' Works. Naphthalene prices are unchanged and are in accordance with the Control of Tar Order 1941. The Order refers to maximum prices, and the figure for refined crystal naphthalene in 2-cwt. bags and 4-ton lots is £23 per ton delivered.

The Provinces Jan. 26.

The average prices of gas-works products during the week were: Pitch and Crude Tar,* Toluole, naked, North, 1s. 10d. (controlled by the Control of Toluene No. 2 Order, July 5, which fixes the maximum price at which this material may be sold). Coal tar, crude naphtha, in bulk, North, 11d. to 1s. Solvent naphtha, naked, North, 1s. 9d. to 1s. 10d. Heavy naphtha, North, 1s. 9d. to 1s. 10d. Creosote, *ex* works, in bulk, North, liquid and salty, 4½d. to 4¾d.; Scotland, 4½d. to 4¾d.; low gravity, 4½d. to 4¾d. Fuel Grade, 4d. to 4½d. Carbolic acid, 60's, 3s. 7½d. to 3s. 9d. Naphthalene, £15 to £20. Salts, drained, £6 to £6 10s.; whizzed 72°, £7 15s.; 78°, £9 5s. Anthracene prices fixed by Controller. Heavy oil: Unfiltered anthracene oil (min. gr. 1,080), 6d. to 6½d.; filtered heavy oil (min. gr. 1,080), 6½d. to 7d.; heavy anthracene oil gr. less than 1,080, 5¾d. to 6d.

*In regard to pitch and crude tar prices we would ask readers to refer to the editorial note on p. 396 of the "JOURNAL" for Sept. 10, 1941.

Tar Products in Scotland

GLASGOW, Jan. 24.

Prices continue firm. Refined tar 4¾d. to 5d. home and 4½d. to 4¾d. per gallon export. Creosote oil stronger: Specification oil, 6d. to 6½d.; low gravity, 6¾d. to 7½d.; neutral oil, 6½d. to 6¾d. per gallon; all *ex* Works in bulk Cresylic acid nominal. Pale 99/100%, 4s. 9d. to 5s. 3d.; Pale 97/99%, 4s. 3d. to 4s. 9d.; Dark 97/99%, 4s. to 4s. 3d. per gallon; all *ex* Works in buyers' packages. Crude naphtha 6½d. to 7d. Solvent naphtha: 90/160 grade 2s. per gallon and 90/190 Heavy Naphtha 1s. 9d. per gallon. Pyridines 90/160 grade 14s. and 90/140 grade 16s. per gallon.

Gas Stocks and Shares

Business in Gas stocks and shares was a little heavier than during the previous week, the bulk of the transactions being confined to the stocks of the larger undertakings. Prices, however, where changed show a steady upward movement and particularly is this the case with the fixed-interest issues. The yields on a number of the latter are still very high, especially when compared with similar class stocks of the electrical undertakings, many of which now stand at well over par.

The following price changes were recorded during the week:

OFFICIAL LIST		
Gas Light 3 p.c. Deb.	75—80	+1
Ditto 5 p.c. Deb.	103—107	+½
South Suburban 5 p.c. Pref.	82—87	+4
Ditto 3½ p.c. Red. Pref.	80—85	+2
Tottenham Ord.	75—80	+2
United Kingdom Gas Corporation 4½ p.c. 2nd Non-Cum. Pref.	13/6—15/6	+1/-
Wandsworth 4 p.c. Pref.	68—73	+1
SUPPLEMENTARY LIST		
Reading 4 p.c. Deb.	78—83	+8
PROVINCIAL EXCHANGES		
Bristol 1st 4 p.c. Deb.	100—102	+1
Ditto 2nd 4 p.c. Deb.	97—99	+1
Liverpool Ord.	101½—103½	+1½

TRADE CARDS

FULL particulars of these spaces can be obtained on application to the Publishers. They are designed principally for the use of the firms whose display advertisements cannot be included owing to paper rationing.

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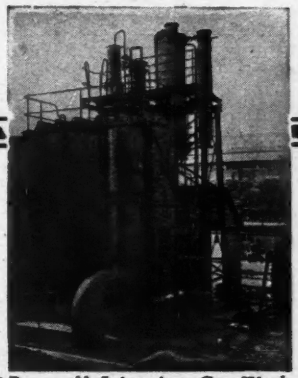
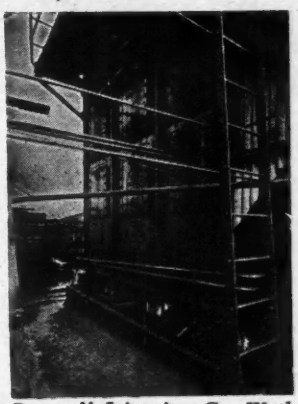


"Permac" Joints in a Gas Works.



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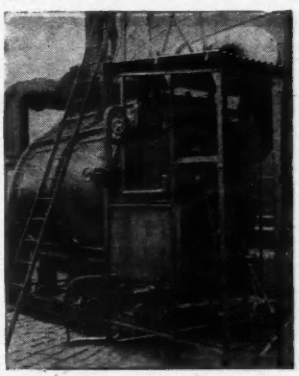

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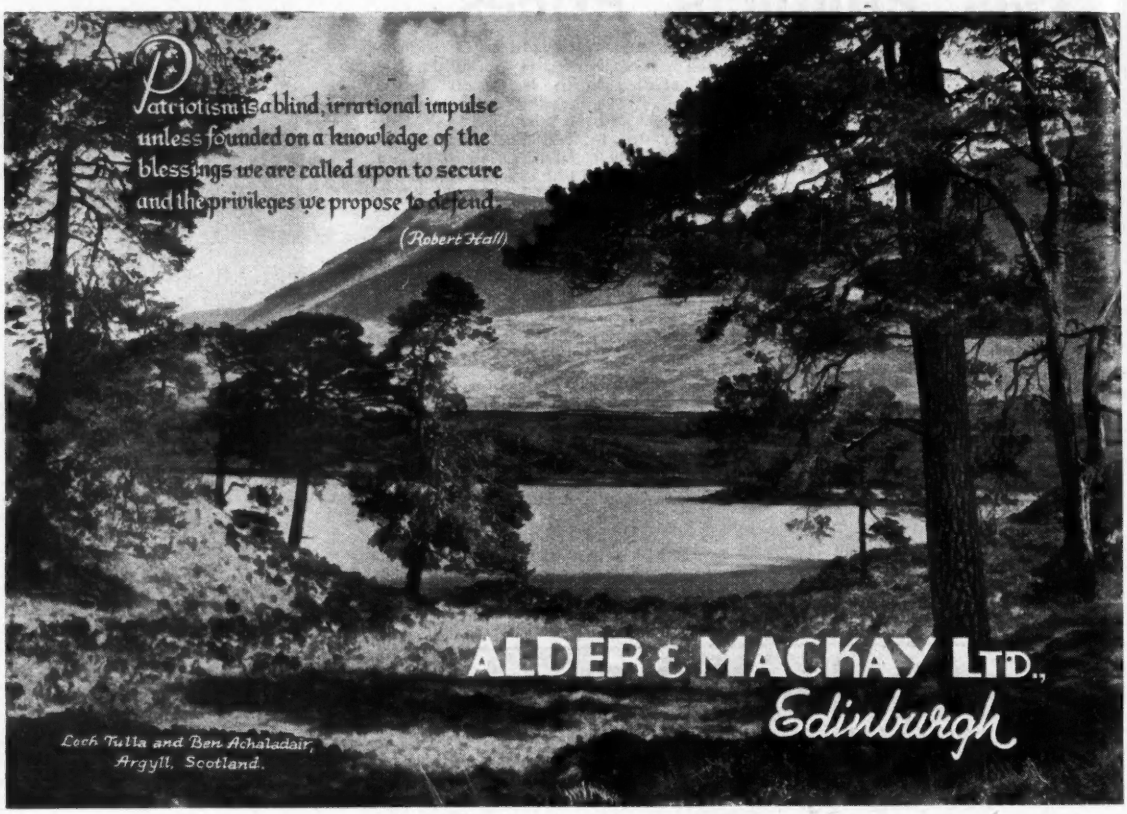
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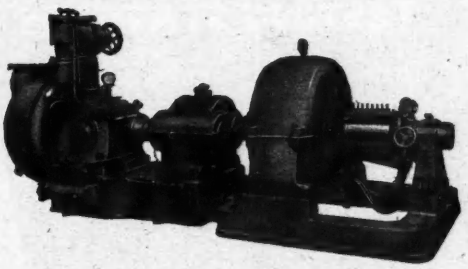

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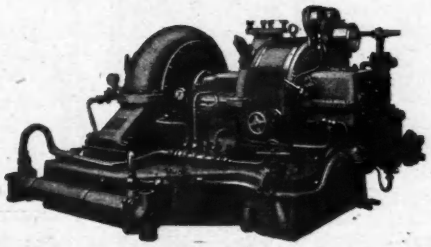

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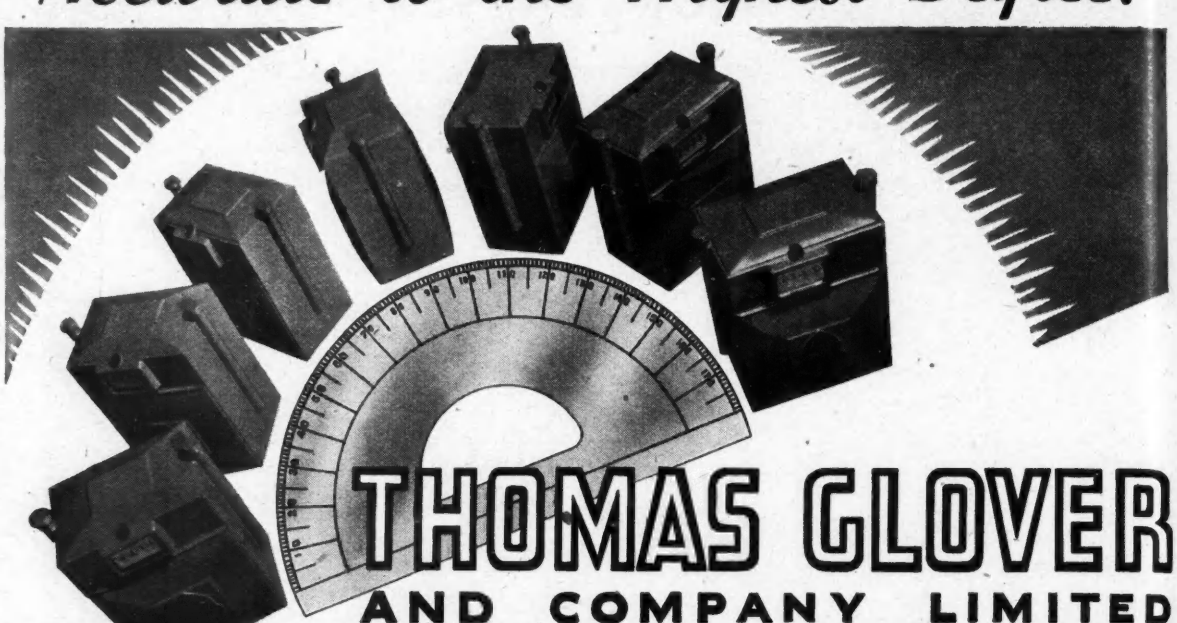

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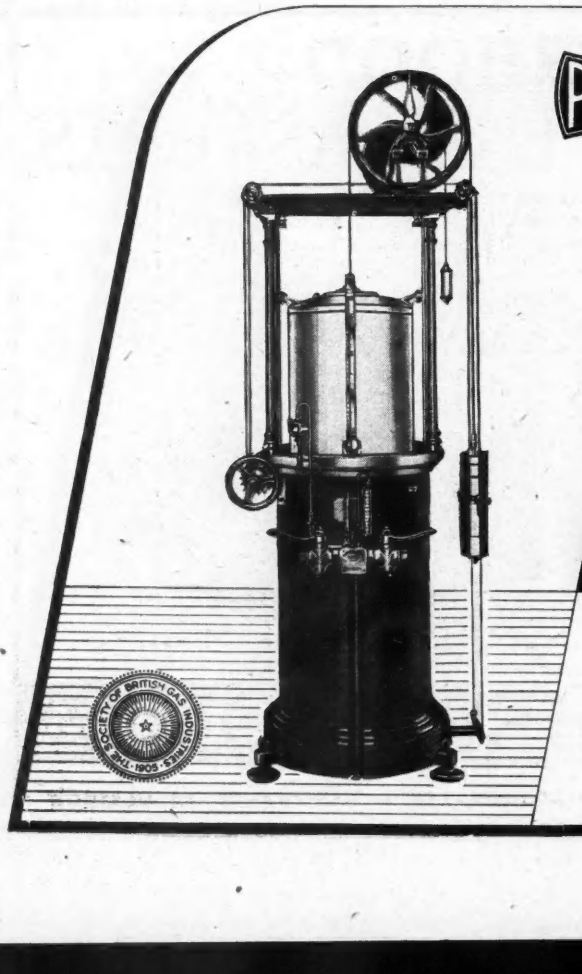

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